THE NATIONAL COMMISSION ON MATHEMATICS AND SCIENCE TEACHING FOR THE 21ST CENTURY

MINUTES OF THE MEETING OF NOVEMBER 29-30, 1999

Commission Members Present:

Sen. John Glenn, Chair
Deborah Loewenberg Ball
Craig R. Barrett
Diane J. Briars
Rep. Cynthia Moore Chestnut
Gov. James E. Geringer
Javier Gonzalez
Jeffrey Himmelstein
Rep. Rush Holt
Anne Jolly
Nancy Keenan
Paul L. Kimmelman
William E. Kirwan
Maria Alicia Lopez-Freeman
Walter E. Massey
Rep. Connie Morella
Edward B. Rust
Dennis Van Roekel
Chang-Lin Tien
Rita R. Colwell (ex officio)
Jerome F. Smith, Jr. (ex officio)
Linda P. Rosen, Designated Federal Official

Other Attendees:
Laura Chow (for Sen. Edward M. Kennedy)
Kelley Coyner (for Sec. Rodney F. Slater)
Carlene Ellis (with Craig R. Barrett)
Peter Falestra (for Sec. Bill Richardson)
Karen Garr (for Gov. James B. Hunt, Jr.)
Alice Gill (for Sandra Feldman)
Susan Hattan (for Sen. James M. Jeffords)
Kathy Havens (with Edward B. Rust, Jr.)
Jay Labov (for Bruce Alberts)
Frank Owens (for Daniel S. Goldin)
Joan Rothenberg (with Rep. Rush Holt)
Jane Butler Kahle (with Rita R. Colwell)
Lisa Towne (for Neal F. Lane)
Sandy Zimmet (with Rep. Connie Morella)

NOVEMBER 29th

Opening Remarks

The National Commission on Mathematics and Science Teaching for the 21st Century met on November 29, 1999, at the Washington Hilton and Towers Hotel in Washington, DC. In accordance with the provisions of Public Law 92-463, the meeting was open to the public. Linda Rosen, Executive Director and Designated Federal Official, called the meeting to order at 3:30 pm and announced the meeting would be taped. She noted the meeting would be devoted to discussion among Commission members and, therefore, questions would not be entertained from the audience. She turned the meeting over to Senator Glenn, Chair of the Commission.

Senator Glenn welcomed members and member designees. He asked for approval of the minutes of the September 23, 1999, meeting and requested the following correction in Senator Kennedy's remarks: "He noted that Glenn has worked closely with the Senate Committee on Education during his 24 years in the Senate." He called for a motion to approve the minutes. The motion was made and seconded and the minutes were unanimously approved. A signed copy of the amended minutes will be posted on the Commission's web site.

Goals for the Meeting

Senator Glenn indicated that to understand the goals for the meeting, it might be helpful to recap the previous meeting. A number of insights were reached: Teaching is a skill that can be learned. There are a variety of approaches to high quality teaching just as there are a variety of styles. A professional knowledge base about high quality teaching in math and science, though not yet well developed, is sorely needed, and teachers must contribute with other professionals to the development of this knowledge base.

While there are other related and important issues, the Commission's charge, and expertise, is to focus on teaching quality. Teaching quality can be described as the interaction between teacher and his/her students in facilitating the learning process. Teachers may be highly qualified on paper but they must be able to use their knowledge to ensure that all students learn important math and science skills. What happens when teachers close the door to their classroom and practice their craft? Not as much might be known about teaching quality as we would hope. It was agreed to defer the discussion of the continuum of a teacher's career for the third meeting in March. The Commission agreed to focus on math and science teaching quality at the November meeting (the interaction between teacher and students), teacher quality (preparation, induction, and professional development) at the next meeting, action strategies at the fourth, and fine tuning the final product at the fifth.

Glenn noted that the Commission's work should informed by, but not duplicate the work of other groups in math and science education. The Commission's final message must be compelling and concise. The final product will consist of a short list of recommendations with corresponding action strategies addressed to various stakeholders to put those recommendations in place. Members want the report to garner significant public attention and capture people's imagination so that the recommendations move towards implementation.

Senator Glenn then set out the goals for this meeting: to identify a set of core premises about high quality teaching in math and science that will form the basis of the final report; and to draft two or three recommendations that might emerge in the final report related to teaching quality. Senator Glenn recognized the following Commission members for their work in planning this meeting: Deborah Ball, Diane Briars, Alice Gill on behalf of Sandra Feldman, Anne Jolly, and Maria Lopez-Freeman.

Senator Glenn shared a quote from a 1958 article in *Life* Magazine: "Teachers hold in their hands the malleable minds of the Nation's children but despite the immense importance of what they do or should do, they are wretchedly overworked, underpaid, and disregarded and a discouraging number of them are incompetents." He commented that the statement is still applicable today.

Presentation: Then, Now, Tomorrow—Reflections on Two Missions

Senator Glenn compared his two space missions, contrasting the preparation, skills, and the differences in science and math knowledge. In 1962, computers were rare and were huge. The computer that was running the centrifuge was half a gymnasium in size and ran with vacuum tubes, not transistors. When something went awry, the technicians would go up and down the rows on ladders trying to find which vacuum tube had blown. In contrast, on his recent flight, not only were there main computers, but also 18 laptop computers plus two spares on board to run 83 different experiments and record all the data during the flight.

In 1962, of most concern was what would happen to the human body. For example, Glenn read an eye chart every 20 minutes to see if his eyes were changing shape. The 83 research projects on his second flight varied from observations about the sun's corona and the solar winds coming from the sun that affect communications to micro-molecular biology studies as well as studies on aging.

Presentation: What is Known About High Quality Teaching in Mathematics and Science? What Does It Entail?

Senator Glenn introduced Nanette Seago, Project Director for the Video Cases for Mathematics Professional Development Project. Seago asked members to think of images of teaching found in movies. She suggested that those images seduce us into thinking that teaching is simple and straightforward. She indicated that she would focus on looking deeper at teaching, at the process of teaching, at the teacher and student interaction around learning a concept. She suggested that teaching is complex and that there are a variety of teaching methods.

Seago introduced a video segment of a third-grade class that was culturally, racially, and linguistically diverse. The purpose of the lesson was to let the students recognize how subtraction arises in a story context, to provide practice in using subtraction with regrouping in solving a problem, and to make the mathematical connections using representations. Seago divided Commission members into groups to watch the video and assigned each group to focus on either the content, the students, the environment for learning, or the teaching. Members viewed the video, met in groups to discuss their focus assignment, and then reconvened in plenary for reporting and discussion.

Members shared their observations of the video. Seago summarized the discussion and conclusions. Teaching mathematics and science is complex and multi-dimensional. The tools, strategies, and knowledge that teachers need to facilitate learning involves a variety of decisions. Teachers have to know both the subject matter and the students. Methods that produce or impede children's learning ought to be studied and understood. The ultimate aim is to have children in this country learn mathematics and science. Questions ensued.

Referring to videos of Japanese classrooms seen at the previous Commission meeting, Senator Glenn asked how the teaching methods used in a Japanese classroom would differ from what was seen in the video. Kimmelman suggested that the methods were similar in that the students were engaged, were allowed to question themselves, could politely disagree, and could use more than one procedure in their work. Seago pointed out that the previous videos that Dr. Stigler showed were aimed at studying teaching at a macro level, looking at patterns and themes that emerged culturally in the U.S., Japan, and Germany. The video she showed aimed at looking deeply at a particular moment in a particular classroom to illustrate the complexity of teaching. Tien added that measuring teacher effectiveness is even more complex. In addition to skills, quality teaching also requires creativity and deep comprehension. Senator Glenn called for a short break.

Presentation: What is Known About High Quality Teaching in Mathematics and Science? What is Known from Research?

Senator Glenn introduced Deborah Ball, Commission Member and Professor of Mathematics Education and Teacher Education at the University of Michigan. She is currently co-directing a longitudinal study designed to improve instruction and learning in mathematics in high-poverty elementary schools and is also directing a study focusing on the practice of elementary mathematics teaching.

Ball presented a synopsis of core findings from varied relevant research on teaching using a diagram of what teaching and learning entail (Attachment A). She suggested that the diagram illustrates that what happens in any classroom is a product of a set of relationships among teacher, students, and content, not simply about what teachers do to students or with curriculum materials. The dynamic among these relationships is what produces the opportunity to learn in the classroom and is what produces differences across lessons. She suggested that understanding this set of relationships is key to thinking about strategies for improving instruction. Ball discussed each side of the triangle in the diagram.

Teacher and Content: The U.S. relies substantially on commercial textbooks. Little is known about the extent to which teachers have access to and use supplementary materials, but early research revealed that the teacher's guide is used primarily as an answer key only. Teachers exercise autonomy in their use of the textbook, omitting or reordering lessons, altering suggested activities. Teachers' sense of mathematics reasoning shapes their use of textbooks, as do their beliefs about the nature of the subjects and how students learn.

Students and Content: Students develop and bring to school scientific ideas from everyday experience, some of which provide a useful foundation for learning; some of which are persistently at odds with scientific explanations. Much mathematics and science instruction proceeds without addressing these differences. Some mathematical

topics tend to be predictably difficult for students to grasp. Student learning in math and science depends on being able to move back and forth among abstract and concrete representations. Mathematics and science are not taught everyday in elementary classrooms even though research has shown that the amount of time students are engaged in worthwhile tasks has a significant impact on their learning.

Teacher and Students: This relationship is bi-directional. Teachers have a fundamental reliance on students and cannot make students learn. Students shape instruction. Students are shaped by peer attitudes and ideas. Teachers who hold and convey high expectations get better results. Teaching depends on teachers' capacity to determine their students' understanding, which is affected by teachers' own content knowledge and their knowledge of student learning. Understanding how someone else thinks is a challenge, requiring a flexibility of knowledge and the capacity to unpack the components that add up to a set of beliefs.

Ball continued that another crucial understanding from research is that the environment has a critical impact on teaching. Few discussions of policy, standards, and frameworks take into account the way in which the environment permeates—is really internal to—the classroom. The environment affects classroom instruction through teacher and students, through parents' and other community members' views, through multiple and mixed signals about goals and outcomes via curricular guidance, and through incentives for teachers and students. These external forces are also interpreted differently by different players.

Ball said that efforts to improve instruction must improve the effectiveness of the interactions in the triangle. She advised focusing on: use of knowledge, incentives for performance, and instructional coordination. She indicated that instruction is shaped not only by what teachers know but also how they use the knowledge. The more ambitious the instructional aims, the more complex the knowledge use. We need to consider what the incentives would be for teachers to ask students to do more intellectually challenging work. There are competing ideas about what constitutes success. Teachers have to balance the risk of failure against the ambitiousness of the goals. The problem of incentives is only exacerbated when standards are raised, when accountability is heightened. The challenges of coordination are immense. Teachers have to coordinate the instructional goal, the instructional materials, and the students. Coordination must also take place between classes, grades, tests, parent and community wishes, a fragmented system, and multiple and competing messages. Ball suggested that efforts to improve instruction will fail if they do not pay attention to the incredible lack of coordination.

Commission members posed a number of questions. Himmelstein pointed out that the political realities, requirements to use textbooks, dictates of school boards, often contradict good science. In response to Kimmelman's questions about research on the diverse classroom and how teachers might confront the unwilling learner, Ball responded that teachers must find ways to help students be engaged in academic work that does not distort or degrade the task unintentionally. She indicated that there was a lot of work on motivating learners. She suggested that raising standards, the willingness of teachers and students to engage in difficult work, the patience to let students struggle, are bound together. Currently there are disincentives to letting students struggle.

In response to Massey's question about the audience most receptive to research results—schools of education, school boards, the Federal Government—Ball responded that research had not yet been assembled nor studied longitudinally. If the Commission were to recommend that this research is the basis of policymaking, all of these groups will have to be involved. The important question is what sorts of roles could different constituencies and stakeholders and institutions play.

Representative Holt asked if it would be useful to look around the country for best practice schools. Ball responded that although there are sites that are useful to look at, most target one element or another, not all the parts of the system. In response to a question about the characteristics of worthwhile tasks, Ball noted a dilemma. Identifying one task over another as worthwhile depends on the desired outcome for students.

In response to Tien's question about research on the teaching of mathematics and science in an era of technology innovation, Ball answered that, like any curriculum materials, it depends on how technology is used. Materials by themselves don't teach. Himmelstein asked if research existed on science curriculum not based on textbooks. Ball concluded her remarks indicating that there are studies about how teachers make use of those types of curricula. Again, there is mediation of the teacher with the curriculum material so studies are difficult because the interaction is among students, teacher, and curriculum.

Rosen thanked Ball and reiterated the meeting's goal of producing a set of core premises that are descriptors of high quality teaching in math and science. To make a set of recommendations that would help ensure high quality instruction in math and science nationwide, it is critical that the Commission create an easily understood definition of high quality teaching. The planning group thought this could emerge from a set of core premises which is a series of statements that are clearly and obviously necessary and sufficient. A suggestion was made to describe the purpose of the premise as related to student or societal achievement and benefits. Senator Glenn adjourned the meeting at 6:30 pm.

NOVEMBER 30th

Overview for the Day

Senator Glenn called the meeting to order at 8:30 am. Senator Glenn reminded the members of the two goals for the meeting: to develop a set of compelling and concise core premises about high quality math and science teaching and to develop two or three recommendations that might emerge in our final report about teaching quality. He indicated that this was not the first group to try to improve quality and few have had long-lasting success. The reasons for a lack of staying power should inform our thinking. Some programs have emphasized getting more people into teaching, other have focused on financial incentives such as loan forgiveness for teachers, still others have focused on short-cut paths into the classroom and the list could go on and on. This is not enough to really improve the quality of teaching in the long term. This Commission can make some pointed recommendations that are based on math and science teaching. There will be other recommendations as well, some that focus on teacher preparation, recruitment, retention, and professional development that will emerge in meeting three.

Senator Glenn introduced Dr. Michael Barber, head of standards and assessments in the UK and an adviser to Tony Blair.

Presentation: Mathematics in Primary Schools in the United Kingdom

Barber shared with the Commission the steps that the UK has been taking to improve literacy and numeracy teaching in primary schools in order to have a world-class system in 2005. A worldwide study on the teaching of mathematics at the primary level identified an approach used in Switzerland, Holland, and the Pacific Rim that included having every primary teacher deliver a daily mathematics lesson of an hour in length with interactive whole-class teaching. High-quality materials about what teachers should expect students, from age five to age eleven, to learn, along with professional development materials for trainers and participants were developed and delivered to every school. In the summer of 1999, a professional development program was widely implemented. A new curriculum was introduced into every university that provides teacher education. In September, every school began teaching the daily mathematics lesson according to that model.

To try to influence the culture to value mathematics and mathematics teaching more highly, the year 2000 is called Math Year 2000. From January on, the government will run a series of TV ads showing parents activities they can do at home to reinforce the math strategy in schools. All primary schools will have their results published in the news.

Barber said that a parallel exercise in literacy in the teaching of reading and writing, started a year earlier, has already proved in the test scores and classroom practice that rapid change is possible if you get the alignment right. He suggested four key lessons: it is essential to link and align pre-service education so that new teachers are ready to teach in the changed system; it is important to align the standards, the curriculum, and the assessments; a major and sustained effort in professional development is essential; and aligning pressures and supports is critical.

The speaker noted that the cost for the professional development is 18 million pounds a year for three years. The best practices study in worldwide research was published in 1997. He concluded his remarks by sharing that there was initial resistance but complaints now are related to the amount of work required to make the change. If you set out to change beliefs at first, it makes sense to change behaviors. If they see that practice works, beliefs will follow.

Rosen thanked Barber.

Plenary Session: What Are the Core Premises of Effective Mathematics and Science Teaching?

Commission members brainstormed possible core premises of effective mathematics and science teaching. (A list of the proposed ideas can be found in Attachment B)

A break was called at 10:00 am.

Presentation: What Does It Take for Teachers of Math and Science to Deliver High Quality Instruction?

Senator Glenn introduced Suzanne Wilson, Associate Professor at Michigan State University, Department of Teacher Education. Wilson has taught prospective and practicing teachers, as well as prospective teacher educators and researchers.

Wilson suggested each of us has opinions about what it takes to teach and that this presumption is problematic because what works for us doesn't work for everyone and experiencing good teaching is not the same thing as understanding good teaching. Good teaching requires more than simply caring for kids and having a command of the subject matter. She continued that there is not a clear match between the K-12 curriculum that teachers are expected to teach and what they learn if they major in a subject matter in the university. Science teachers get assigned to teach everything under the umbrella of science, not just what they majored in. Science and math majors also are counseled out of taking certain courses if they plan on teaching.

Wilson suggested that subject matter knowledge, pedagogical content knowledge, and knowledge of instructional strategies are all necessary for good teaching. She indicated that there is considerable controversy over who “owns” the undergraduate preparation of teachers in the subject matters. Teachers need to know the subject matter they teach. Teachers also need to have pedagogically-sensitive knowledge of the subject matter in terms of what students understand and what they have trouble with. Wilson continued that teachers need to have a sense of a range of instructional strategies that can help them create opportunities to help kids work through their beliefs and come out the other end with more valid beliefs and with knowledge that will last.

Pedagogically sensitive subject matter knowledge is currently uneven. This knowledge is now acquired in the classroom. She suggested that there's danger in presuming that this professional knowledge will grow out of schools as they exist. She advised that a way must be found to support development of the knowledge base in schools. Good practice involves the chemistry that one can create between a set of pedagogical practices, students, the teacher, and the subject matter.

Questions and comments by Commission members followed. In response to Himmelstein’s question about differences in the way math and science teachers need to be prepared, Wilson answered that there are deep subject specific differences, differences in inquiry, but that they are currently presented the same by schools. Governor Geringer asked if teacher preparation institutions should encourage prospective teachers to major in the subject matter or education. Wilson responded that this was a matter of debate but her view was that it is important for teachers to love the subject matter. She cautioned, however, that simply loving the subject matter is a necessary but not sufficient condition of good teaching.

Tien commented that parents and family have an important role to play.

Panel Presentation: What Does It Take for Teachers of Math and Science to Deliver High Quality Instruction?

Senator Glenn thanked Wilson and introduced the panelists who would discuss what is needed for teachers to deliver high quality math and science instruction: Michael Lach, Cindy Chapman, Janice Jackson, and Barbara Blumenthal.

Lach suggested a number of things that teachers need to enable them to deliver high quality math and science instruction: content knowledge, subject specific pedagogical knowledge, administrative support, the ability to relate to students, the ability to think on one's feet, and a vision of accomplished practice to emulate and to inspire teachers to want to improve their practice. He cited lack of sufficient materials and supplies, facilities in disrepair, and large class sizes as detriments to good teaching. Lach said that high quality instruction demands the integration of the research base with the teacher, the student and the environment. Teachers need the freedom and flexibility to be innovative and creative and they need to be accountable in meaningful ways for those results. There are wonderful teachers in every school who want to create wonderful learning experiences but they're often not recognized and they are rarely empowered to help other teachers attain that same success.

Chapman indicated that her school is able to provide tremendous support to its teachers. As an elementary school teacher, she has been able to participate in excellent professional development opportunities, particularly in mathematics and science. She suggested that the Commission's recommendations must address the need for teachers to be taught content knowledge in the ways they will teach it to their students.

Jackson suggested that in order to get results, you have to pay attention to process. She indicated students need experiences that allow them to see how their work connects to what happens outside of schools. Teachers need mentors and feedback on the work they're doing. Teachers need materials that they understand, that make sense to them, but that also help them ponder and encourage them find out more about what they do not know. Teachers need to understand knowledge about how children learn. Jackson suggested that good teaching requires an inquiring mind. She said that teachers need time for reflection and opportunities to dissect what they are doing. This could be through study groups where teachers look at problems of practice they choose, not what the administrator or researcher chooses. Coaches and mentors to teachers in the classroom are also beneficial. Jackson encouraged the Commission to look at how change and reform in the business community can be translated to help education.

Blumenthal pointed out that efforts to reform education have directly avoided what happens in the classroom. She suggested that a large cultural change is required to improve math and science because the vast majority of teachers are comfortable with what they are currently doing. Widespread cultural change in business organizations have led to performance improvements. When business processes and systems are improved, employees perform well. In education, leadership must be developed at the local level to help teachers not already motivated to change to want to improve their performance. Blumenthal suggested an approach is needed that is much more bottom up, that really engages teachers and their willingness to make improvements. She suggested focusing on the process of change and how to get an organization from here to there.

Questions and comments ensued. In response to a question from Gonzalez about dealing with the bureaucracy and lack of support, the panelists said that teachers cannot be held accountable for things over which they have no control. They added that, at the same time, teachers want a lot of accountability. The question is not whom to blame, but whether at each level of the organization, what must occur to enable and support high quality teaching.

In response to Himmelstein's question as to which courses were most valuable, Chapman described courses that focus on how to teach particular subject matter. Whether or not any one person can adequately teach the wide array of disciplines required in elementary school deserves careful and thoughtful analysis.

In response to a question about pay for performance and other incentives, the panelists suggested that not enough is known about assessing what students know about science in a way that makes for sound policy. Performance has to be measured with multiple measures. It is important to avoid competition among teachers when it comes to incentives since such competition discourages sharing of professional expertise. There must be a climate of trust where learning among peers can happen, trust that you won't be punished for trying something new. Panelists suggested that it is scary for professionals to consider changing the way they have done something for 10 or 15 years, and that they won't be punished for their resulting incompetence. Leadership has to create an environment that fosters trust and openness.

In response to Kirwan's question about the use of technology in helping students learn, the panelists suggested that technology has a number of important uses, in collecting and processing scientific data, in student research, in helping teachers organize and manage their equipment and materials. But the focus to date has been on getting hardware, not about instruction. There must be much more thinking and dialog about how to use technology.

Senator Glenn thanked the panelists and called for a lunch break at 12:30 pm.

Plenary Discussion: What Teaching Quality Recommendations Should be Considered?

Senator Glenn called the meeting to order at 1:30 pm. He made a number of introductory remarks about what teaching quality recommendations should be considered. There are examples of great teaching techniques across the country that could be put on tapes and provided to every teacher in the country. Is pointing out teaching techniques sufficient? What level do we want to kids to achieve? What level is necessary in this competitive world? What do we want the level of accomplishment to be? What is doable? Is it useful to try to better define our end product and then define the steps to get there? Senator Glenn asked members to think about these questions. Discussion followed about possible goals and issues for the Commission to consider as well as possible teaching quality recommendations. (A list of possible questions and issues can be found in Attachment C and a list of possible teaching quality recommendations can be found in Attachment D)

Virtual Hearings

Rosen called attention to the virtual hearings and demonstrated the web site that was created to gather widespread public input. She explained that the goal is to provide feedback to the Commission and for the site to be easy to navigate. The minutes and the presentations from the first meeting are available on the web site. Staff will synthesize feedback from the web site. Members' ideas as to what should be included on the site are welcome as are their efforts to publicize the site. This process will continue for future Commission meetings.

Decisions: Summary of Meeting Two and Preview of Meeting Three

Rosen thanked the five Commission members who worked very hard with staff to plan and organize the meeting. She noted that Kimmelman, Himmelstein, and Garr (on behalf of Governor Hunt) had indicated interest in working on meeting three--the continuum of a professional life going from teacher preparation, recruitment, retention, and professional development. She invited other interested members to join the planning group and noted that the goal of the March 2000 meeting was to develop preliminary drafts of some recommendations for the final report.

Rosen also described a special opening session in March on the potential impact of technology on math and science teaching that was being organized and hosted by the Association for Computing Machinery. Although not officially part of the Commission meeting, the Department would provide support for all members to attend if an additional night's lodging was needed.

Senator Glenn said we would not reach an action-oriented result from the Commission unless school boards are addressed directly because they can impact many different aspects. Governor Geringer indicated that the Commission needed to decide on what to focus its ultimate recommendations, primarily on current teachers or on the training of future teachers, or a combination of both. Rosen suggested the need to focus on both short- and long-term solutions, on teachers currently in the classroom and those coming into teaching.

Echoing Senator Glenn's comments about school boards, Gonzalez suggested that the power of change is within the school boards but it has to start in the classrooms and have the support of the school board. He suggested a presentation be made to or document be sent to the school boards association of every state about the Commission's direction and preliminary recommendations.

In comments written before his departure, and read aloud, Representative Holt suggested that subsequent meetings explore the differences, if any, between math and science -- differences in recruitment, retention, classroom culture, assessments, and achievement. Himmelstein concurred and asked about research evidence that provided insight into the fundamental differences in math and science.

Briars urged the Commission to address its recommendations to both pre-service and in-service. It is important to have new people coming into the system with the preparation to teach the way we would like them to teach. At the same time, existing teachers are an essential part of the culture of the school and their support is needed to make lasting

change. She agreed that school boards need to be addressed. She added that evidence from systemic reform efforts suggests that, if the Commission's recommendations are focused along with appropriate incentives, so that districts don't have to fund on their own the necessary changes, it will be a powerful message. School board members are reluctant to vote for changes that would require taxes to be raised and could result in their being voted out of office.

Kimmelman commented that the agenda seemed broadened with the request for international comparisons (see attachments) and asked if there is sufficient time scheduled between now and September to complete the agenda. He suggested that to hear international reports about what is transpiring in other countries would require an additional meeting and indicated that he would make whatever commitment is necessary.

Himmelstein suggested expanding meetings to two full days. He also asked if smaller meetings, without a quorum, were an option. Rosen responded that just as there was a subcommittee of members who worked to plan this meeting, subsets of Commission members can work on a variety of issues and share those efforts with the entire Commission. She advised, however, that the Commission cannot tackle everything and suggested taking the time to digest all that has transpired, putting forward a number of questions that will help the Commission decide next steps. She suggested that they keep in mind what the Commission, with its broad membership and constituencies, is uniquely constituted to do. The expertise that they bring to the task must match what they are trying to accomplish. There are other groups that have different sets of expertise that are dealing with different parts of the challenge. She suggested that a background document of other efforts and their status might be useful way to get a better sense of the landscape while reflecting on what this group is best equipped to do. She turned the meeting over to Senator Glenn and he called for adjournment at 4:30 pm.

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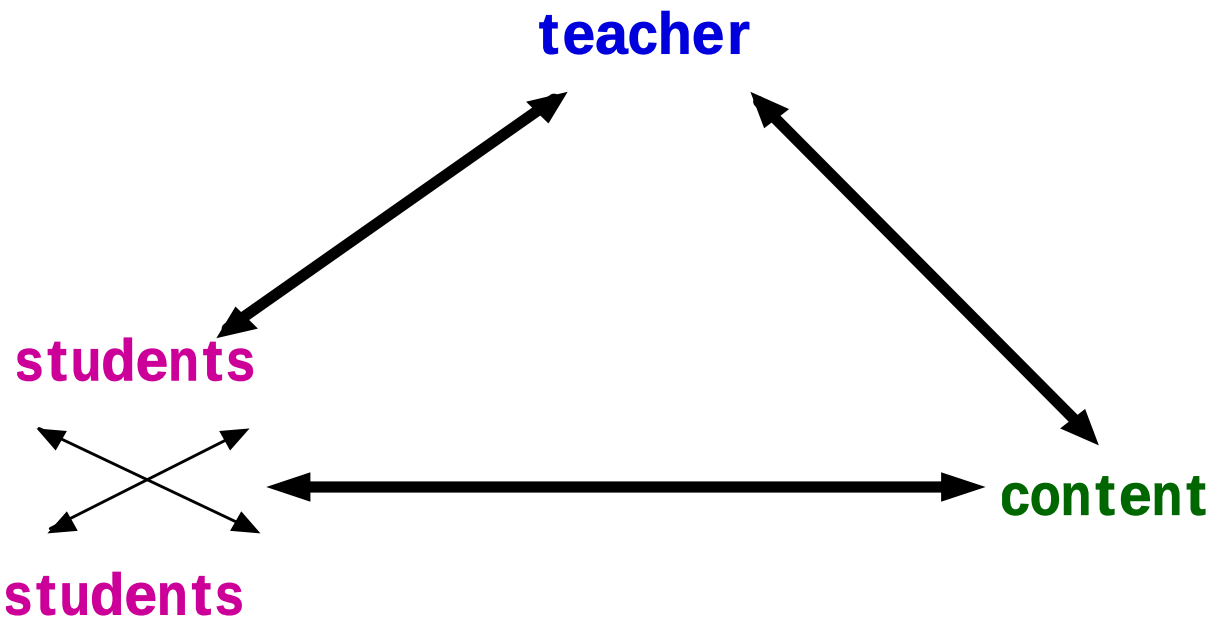
This is to certify that the minutes of the November 29-30, 1999 meeting of the National Commission on Mathematics and Science Teaching for the 21st Century are true and accurate to the best of my knowledge.

(Signed by John Glenn)	March 6, 2000
John Glenn, Chairman	Date

Attachment A



Attachment B

POSSIBLE CORE PREMISES OF HIGH QUALITY MATHEMATICS AND SCIENCE TEACHING

Good mathematics and science teaching builds on, expands, and deepens the knowledge that students have (and bring), leading them to understand fundamental concepts, processes, and applications of the disciplines.

Live mathematics and science or die.

Good mathematics and science teaching gives students essential skills for their personal lives as well as for participation in the economy and society. Problem solving skills – the capacity to be able to solve problems that don't have ready answers.

Place emphasis on content and effective instructional practices in preservice education, and continuing into practice. For example, helping teachers learn to make effective use of quality instructional materials.

Good instructional materials are crucial as is giving teachers quality professional development to make good use of them. Teachers shouldn't have to spend time creating materials.

Link to NBPTS as a means to address retention problem.

Two issues: (1) core premises of good teaching, (2) essential structures to support such teaching (professional development, materials). The first is not possible without the second.

Good mathematics and science teaching is standards- and assessment-based.

Good mathematics and science teaching uses inquiry-based learning methods. This is different from the teacher "giving instruction."

Need to shift to more emphasis on learning, not teaching.

The disciplines of mathematics and science are integral to good mathematics and science teaching.

Good mathematics and science teaching reflects high expectations for all students and uses instructional practices that meet individual student needs.

The purpose of math and science instruction is not to make math and science complicated subjects but to make them accessible to, understandable, and applicable for all students.

Good mathematics and science teaching engages students in core practices of mathematics and science (e.g., conjecturing, experimenting) and helps students learn to justify knowledge in ways that are consistent with practices in the disciplines.

An essential part of the environment for good teaching is a commitment to ongoing professional development.

Core premises of good mathematics and science teaching results in American children being first or second in the world in mathematics and science achievement. Process is important but product matters – the students' ability to use what they learn.

Good mathematics and science teaching is fun for both pupils and teachers.

Good mathematics and science teaching allows for, recognizes, and builds on differences in learning styles and abilities.

Learning is the resolution of curiosity.

Good questioning (getting children to clarify their own curiosities) is the core of good mathematics and science teaching. (*homo sapiens*)

The core premises should be very simple and specific.

The core premises should be measurable so that we can assess them.

Good mathematics and science teaching reflects the discipline accurately. Requires a lot of content knowledge. Good mathematics and science teaching opens up students' minds to explore and be more innovative.

Results matter. What happens in classrooms that produces those results? Need to look at best practices.

Good mathematics and science teaching requires alignment curriculum, standards, and assessment.

Good mathematics and science teaching begins with recruitment.

Corollary: The recruitment wars require interventions.

Problems of getting enough qualified math and science teachers along with upcoming shortages of teachers. We need to compete with other occupations that also want to recruit talented people in math and science.

We need to build programs for people already in teaching to become qualified to teach math and science.

Good science teaching communicates the essence of science. It encourages students and shows them how to ask questions that can be pursued empirically and verifiably.

Good science teaching challenges, refines, and corrects students' preconceptions.

Good mathematics and science teaching encourages students to engage in healthy skepticism, see the need for evidence, and make informed decisions based on data.

Good mathematics and science teaching inspires wonder and curiosity about the natural world and the way things work.

Good mathematics and science teaching encourages students to become lifelong learners in those subjects.

Good mathematics and science teaching provides time for students to explore their hypotheses and ideas. Good mathematics and science teaching takes time.

In good mathematics and science teaching, instructional decisions are informed by research and the wisdom of others, not merely as a matter of individual choice.

How can we get mathematics and science teaching to engage students in these subjects and make them want to learn math and science?

Good mathematics and science teaching allows for students to expand and demonstrate their unique creativities. This is unique to America.

Need some categories to make these premises less complicated.

Good mathematics and science teaching produces high achievement is the overall frame.

Higher standards for more students requires more investment.

Things have changed – we are after a new kind of goal and we need to do more than the status quo.

Maybe *content, students, instruction, environment* might be fundamental categories for grouping the premises. Others are action strategies.

Often we create action strategies that are not clearly connected to quality teaching and learning; we need to avoid this. We should hold ourselves accountable.

Teachers need to care about their students and establish relationships with them.

Attachment C

QUESTIONS AND ISSUES FOR THE COMMISSION TO CONSIDER

Useful to benchmark ourselves with 5 –10 other top countries that are also working to improve their educational system; learn more about other countries' current practices and policies

International information about other countries' professional development systems

Involvement of industry and the corporate world in the efforts to improve education

What Federal legislation or policy should come from this?

Exploring what it would take to make involvement of scientists, industry, etc. in schools, and to make their contributions useful to and usable by schools, including what everyone would have to learn, and the structures it would take to permit it

What role do we want for teachers? No matter how good our recommendations are, unless teachers can do them, nothing will happen. How can the role be oriented more around instruction?

Role of administrators – are there good models?

How can the incentives be set up so that they don't leave a whole population of children (and groups of teachers) behind?

How can we create the resources that can make a difference to practice and useful to the improvement of teaching and learning? Teachers' crucial role in this

There is so much material out there already available – no one even knows all that already exists

Can we explore what sorts of measures are possible? How do we define quality and how can we measure it? Potential damage that ensues from competition (e.g., ranking states): How can we get all 50 states to be successful?

Competition is crucial. Everything in this country is based on competition. Nothing wrong with states competing with one another if all states' achievement were increasing.

What matters is continuous improvement from the baseline where you are

Role of higher education in improvement of math and science education – teacher preparation & professional development, research

What about models of interdisciplinary programs of teacher education that bring together liberal arts education and education?

TIMSS-R will come out in 2000 and will bring questions of international competitiveness back to the fore

Need to learn more about different approaches to teacher education

ACE report will attract attention by universities and university presidents

Who are our recommendations for? Depending on whom we are targeting, then we should say different things and focus on different aspects.

We are going to have a small number of recommendations and target different audiences. Many groups have to be involved – the problems are systemic ones. Measurement can be criterion-referenced – did THIS child reach this goal or not?

The role of principal as leader

Attachment D

POSSIBLE TEACHING QUALITY RECOMMENDATIONS

Content preparation of teachers – we need something that takes this issue seriously and doesn't repeat the usual call for "more" subject matter, but considers how teachers can learn the sort of understanding of math and science that it takes to teach students.

What should be the subject matter courses taken by education students?

Should the education major still exist? Should it be a shared major with another discipline?

The role of the teacher needs to change to be focused more on instruction (and by "instruction" we mean not just interactive work with students, but also planning, reflection, etc.)

Development of models for a knowledge base for teaching and teachers' role in developing that knowledge.

Elevate appreciation for math and science.

Elevate respect for the teaching profession.

Role of the teacher is to equip students with skills to compete in the workplace or go on to higher learning.

The nature and role of introductory courses in mathematics and science in higher education: What do we want these courses to accomplish for all students? Incentives for faculty to change their teaching of these courses.

The roles of various constituencies in improving teacher education.

Take on issue of commercial and business influence over the content and production of textbooks and assessments: How do school districts and states contribute to this? How much does the commercial production of texts lead to producing what will sell rather than what works.

Need to work on problems in a more integrated way; these are systemic problems.

To create a network of NBPTS-certified teachers who could be a nucleus of discourse about best practices and also the builders of professional development in math and science.